The Deſcription and Uſe of a VII.

# QUADRANT;

*BY WHICH,*

All the moſt uſefull and neceſſary *Propoſitions* of both the GLOBES are eaſily and exactly performed, as the *Right aſcenſion*, *Declination*, *Altitude*, *Amplitude*, *Riſing*, *Setting*, *Azimuth*, and *Houre* of the day.

*ALSO OF A*

# QVADRAT,

By which you may take all manner of *Heights* & *Diſtances*, as of *Towers*, *Steeples*, &c.

And laſtly, of a

# NOCTVRNAL;

For the ready finding of the *Houre* of the *Night*.

---

Publiſhed by *J. H.* for the uſe of ſuch as are *Mathematically* affected.

---

*London*, Printed for the Author. 1665.

BIBLIOTHECA BODLEIANA

# To the READER.

*READER.*

THou art here preſented with the Deſcription and Uſe of a ſmall portable Inſtrument called a QUADRANT, by which all the moſt uſefull and neceſſary *Problems* of both the

the GLOBES may be easily and exactly performed, and also such Propositions in *Geometry*, as concern the taking of Heights of *Buildings*, Distance of *Trees* or other *Objects*, Depths of *Wells* or the like.

The Instrument is in it self *Portable*, in its use *Easie*, and in its performance very *Exact*: If any shall thinke other *Quadrants* more accurate in their *Projections*, so do *I*, but not so easie in *Practice*, nor of so small a *Price*: For which Reasons I do chiefely prefer it,

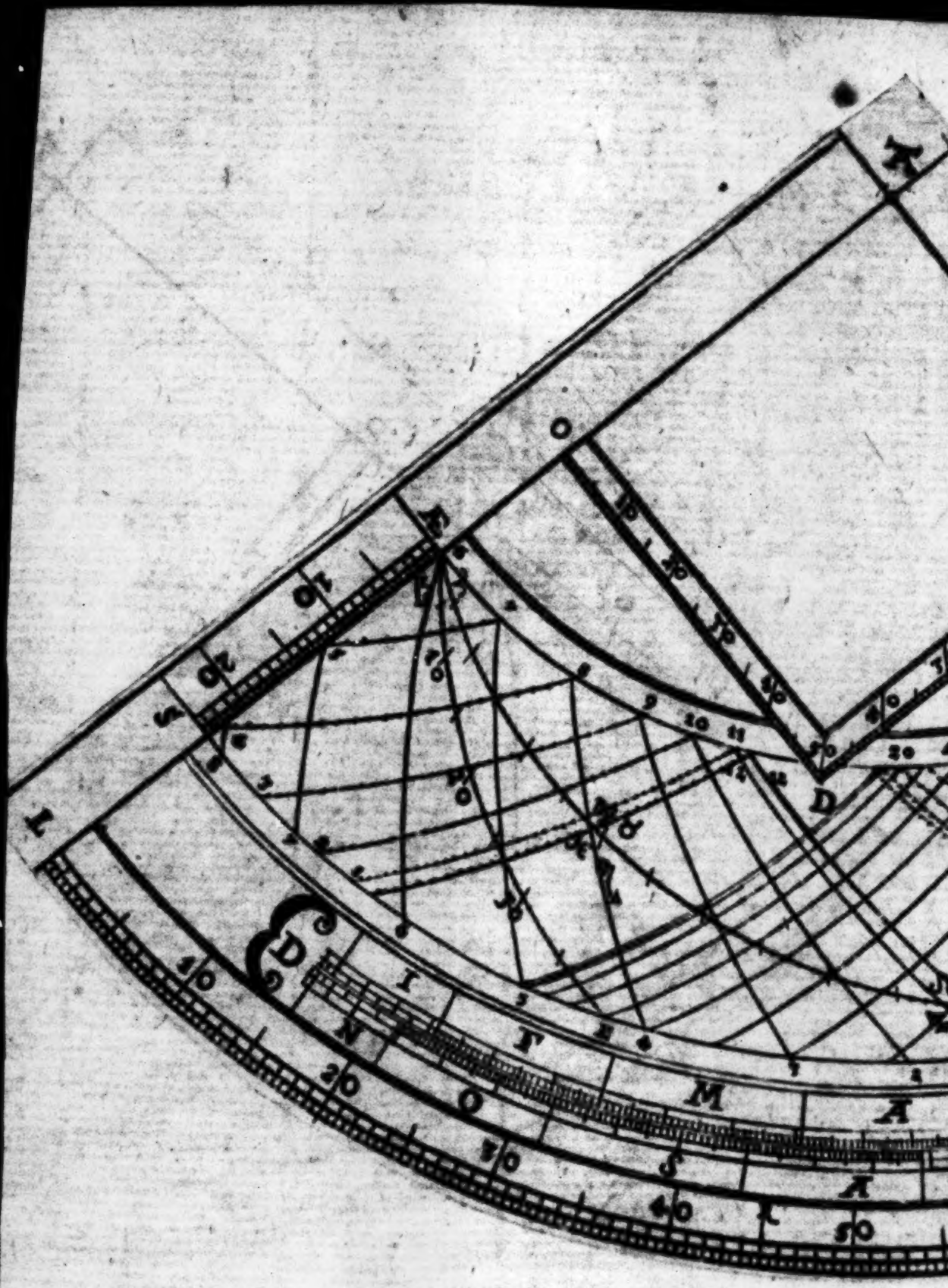
# To the *Reader.*

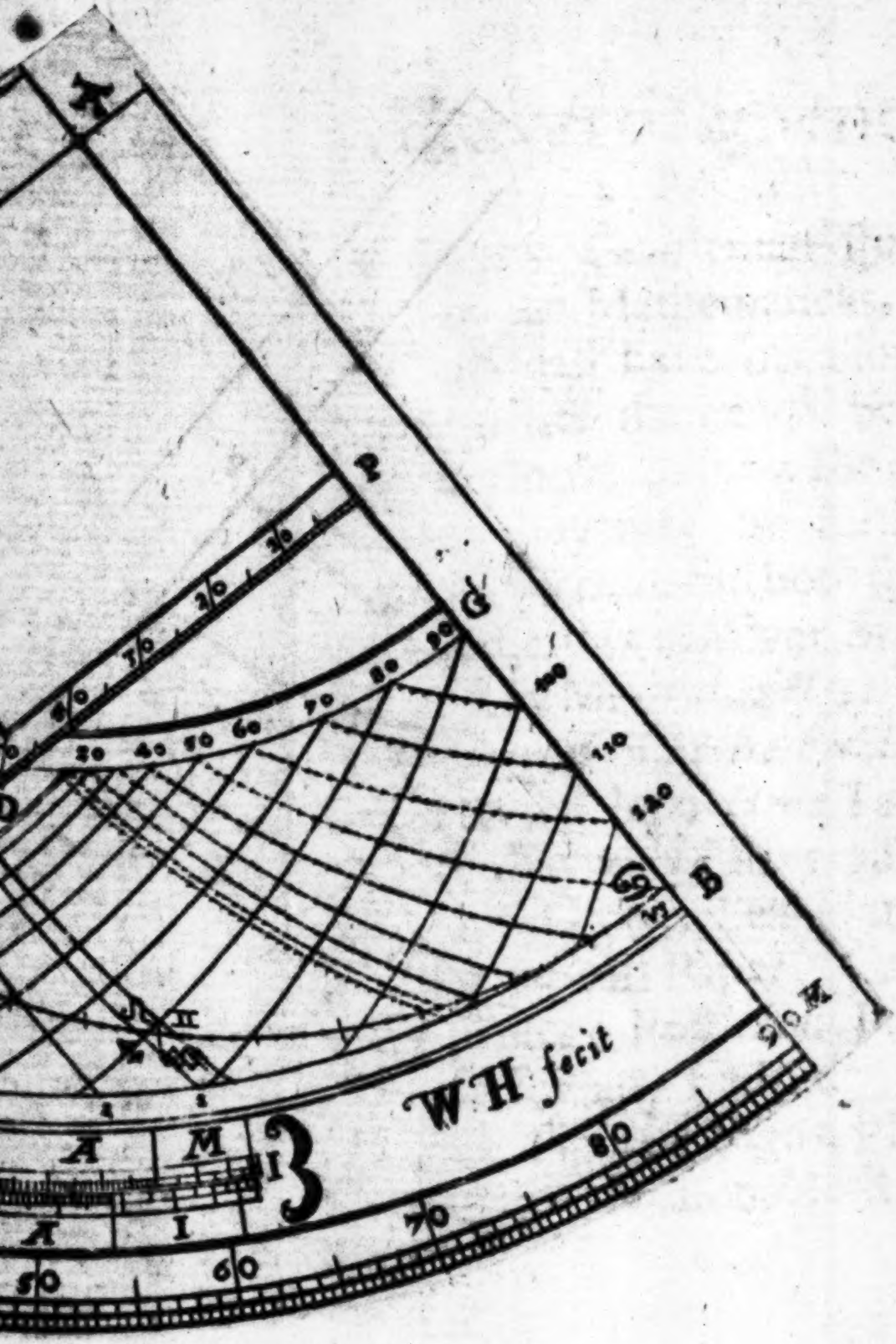
it, desiring thee to make use of this, till I present thee with some other of this kind, which (if I finde this *accepted*) shall be shortly: And in the mean time

Vale.

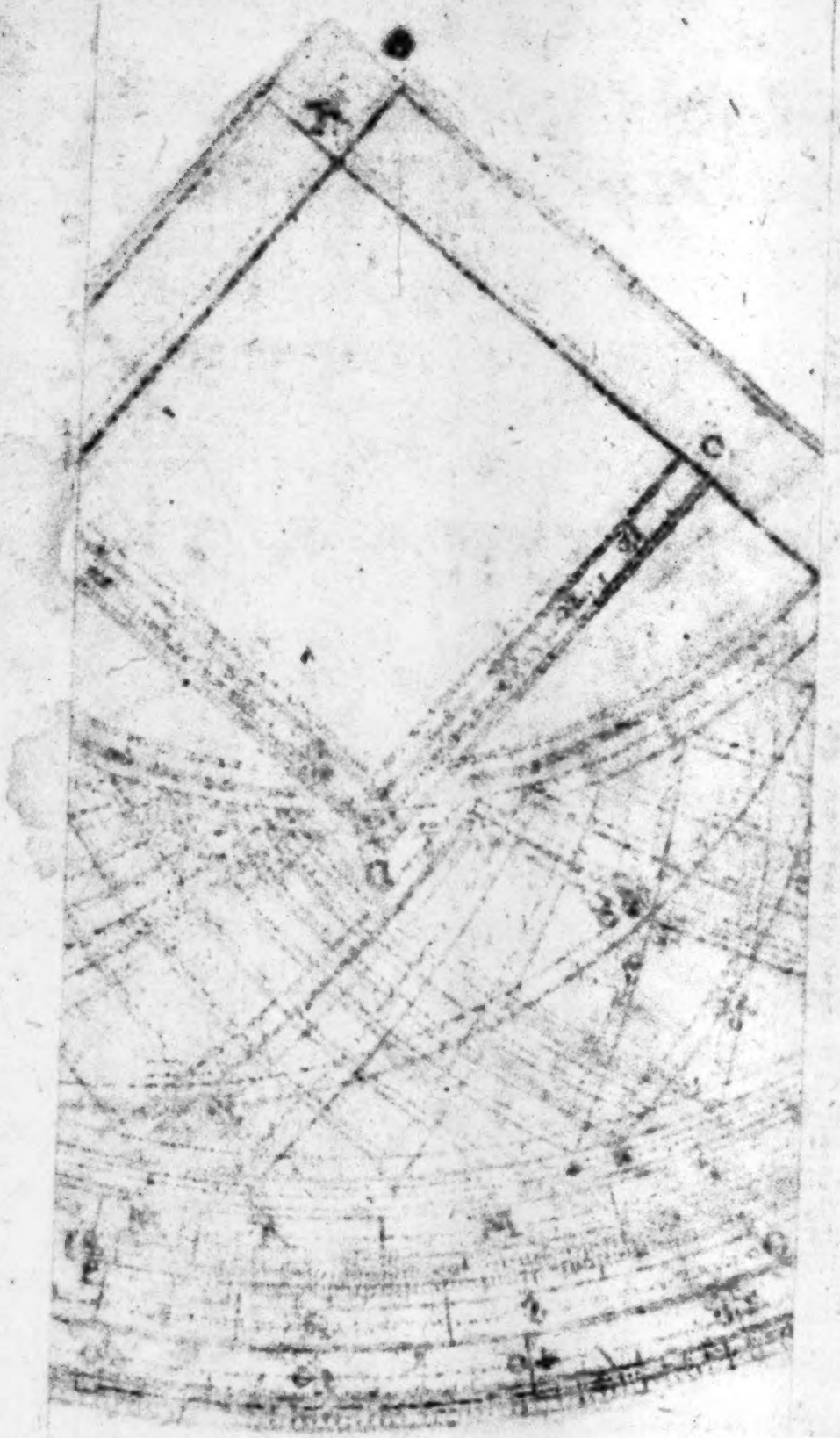
# Advertiſement.

IF any Gentleman ſtudious in the Mathematicks, have, or ſhall have occaſion for Inſtruments thereunto belonging, or Books to ſhew the uſe of them, they may be furniſhed with all ſorts, uſefull both for Sea or Land, either in Silver, Braſs, or Wood, by Mr. *Walter Hayes* at the *Croſs-daggers* in *Moore-Fields*, next door to the *Popes-Head* Tavern; where they may have all ſorts of Maps, Globes, Sea-Plats, and Mathematicall Paper, Carpenters Rules, Poſt and Pocket-Dyalls for any Latitude, Steel Letters, Figures, Signs, Planets, or Aſpects, at reaſonable Rates.





A
P
G
B
M
WH fecit
A
M
I
3
A
I
50
60
70
80
90



# THE *DESCRIPTION* OF THE QUADRANT

BEfore I come to ſhew the ſeverall Uſes of the *Quadrant*, it will be neceſſary, firſt, to let you know what a *Quadrant* is, and then Secondly, to deſcribe unto you the ſeverall Lines thereon graduared.

A *Quadrant*, as it is defined by Geometricians, *Is the fourth part of a Circle, contained under two Semidiameters iſſuing from the Centre of the ſame Circle, and drawn at right angles, which is at* 90 *degrees diſtance one from the other*, and

ſuch is the Figure A L M hereunto annexed, of which Figure, the two ſides A L and A M, are the two *Semidiameters*, meeting one with the other in the point A, which point A is the *Centre* of the *Quadrant*, in which point if you ſet one foot of a pair of Compaſſes. and extend the other foot thereof to L or M, (which lines are of equal length) if you move the foot of the Compaſſes along from L to M, it will deſcribe a crooked line, as the line L R M, which line L R M is called the *Limb* of the *Quadrant*, and the whole Figure comprehended within theſe three lines, A L, A M, & L R M, is called the *Quadrant*: So then,

A L is one Semidiameter
A M the other *Semidiameter* } of the
L R M is the *Limb* } *Quadrant*
A is the *Centre*

Having thus defined what a *Quadrant*

*drant* is, I will now declare unto you what Lines are described upon this *Quadrant*, and what they are called, how numbered; and to what use every particular line serveth.

---

## *A Description of the* Lines *that are Graduated upon the* Quadrant, *and to what Uses they serve.*

FIrst, The *Limb* of the *Quadrant*, which is the line L R M, is divided into 90 equall parts, called Degrees, which degrees are subdivided into halves or quarters, according to the largeneſſe of the *Quadrant*, Theſe Degrees are numbered from L towards M, by 10, 20, 30, &c. to 90 degrees, every Fifth and Tenth deg. being diſtinguiſhed from the reſt

by a longer line. ə The uſe of theſe Degrees ſerve chiefely to take the Altitude or height of the Sunne, Moone or Stars.

Secondly, Above this *Limb* LRM, (and parallel thereto) is drawn another crooked line, as S B in the Figure, which line repreſenteth the two *Tropicks*, namely, either that of *Cancer*, or that of *Capricorn*: Now theſe two Tropicks are thoſe two Circles in the Sphere, which bound or limit the Suns courſe, for the Sun never goeth more Northward than the Tropick of *Cancer*: nor more Southward than the Tropick of *Capricorn*.

Thirdly, Between theſe two lines S B and L R M, are drawn two other concentrick Circles, beginning ar 15 degrees of the *Quadrant*, and reaching to 62 degrees of the ſame: and theſe two Circles are called *The Circles of Moneths*. Of theſe two Circles of Moneths,

Moneths, the undermoſt, which is next to the Quadrants Limbe, containeth that part of the Year which we call *Somer* and *Autumn*, which is from about the tenth of *June*, til the eleventh or twelfth of *December*, all which time the dayes ſhorten to thoſe that live in North Latitude, and lengthen to thoſe that live in the Southern Hemiſphere. The uppermoſt Circle of Moneths containeth that part of the Yeate which wee call *Winter* and *Spring*, which is from about the eleventh of *December* to about the tenth of *June*, . In theſe two circles, each Moneth (at the beginning of it) is noted with the firſt letrer of that Moneth which it repreſenteth, as *I* for *Jannary*, *F* for *February*, *M* fot *March*, &c. Every of theſe Moneths is divided into dayes, every fifth and tenth day being diſtinguiſhed ſtom the reſt by a longer line. The uſe of theſe two

Circles of Moneths is, *to Rectifie the Bead*, (as shall be shewed hereafter) which Bead being rectified, the day of the Moneth only being known, most Questions of the Globe or Sphere, are immediately resolved with great facility.

Fourthly, Above, towards the centre of the Quadrant, is drawn another Circle, noted with Æ G, which representeth the Equinoctial. Now between this line Æ G (the Equinoctial) and the line S B (representing the Tropicks) doth the Sun alwayes move, and never exceedeth those limits, for when the Sun is in *Cancer* the dayes (to us) are longest; when in *Capricorn* shortest: and when in the Equinoctiall, the Dayes and Nights are of equal length.

Fifthly, From Æ to B is drawn a circular line upon the Quadrant, called the *Ecliptick*, and it is first divided

into

into three unequal parts, at the ends of which parts are ſet the characters of the XII. Signes of the Zodiack, in this order: The characters of *Aries* ♈ and *Libra* ♎, ſtand cloſe to Æ in this order ♈ ♎, then at the firſt of the three diviſions next to Æ, ſtand theſe four characters in this forme ♑ ♋ ♓ ♍, which ſheweth, when the Sun is in that part of the Ecliptick line, he is in the beginning of one of thoſe four Signes. At the ſecond of theſe three diviſions are placed theſe four characters in this order ♌ ♎ ♒ ♐; at which place in the Ecliptick when the Sun cometh, he is in the beginning of one of theſe four Signes. At the end of this line, cloſe to the letter B, are placed theſe two characters ♑ and ♑, in this order ♑ ♑ to which place when the Sun cometh, it is either the longeſt or the ſhorteſt

day in the year, *viz.* the longeſt when in *Cancer*, the ſhorteſt when in *Caprl-corn*. Every one of theſe three great diviſions are divided into 30 degrees apiece, and each of them numbred by 10, 20, 30, both backward and forward, according as the Inſtrument is in largeneſſe. This line is called the *Ecliptick*, and it ſheweth in what Signe, and degree of that Signe, the Sun is any day of the yeare.

Sixthly, There is another circular line drawn from Æ to E, which line is divided into 40 unequal parts or degrees, and numbred from Æ towards E by 10, 20, 30, 40, ending at E. This line is called the *Horizon*, and ſheweth every day in the yeare how many degrees the Sun riſes or ſets diſtant from the true Eaſt or Weſt points of the heavens, which is of excellent uſe for Sea-men, for them thereby to finde the Variation of their Compaſſe,

S-

Seventhly, That part of the Semidiameter of the Quadrant which is between the letters Æ and S, is divided into 23 and an half unequal parts, which are numbered by 10, 20, 23½. This line is called the line of *Declination*, and sheweth at any time of the year, how much the Sun in its course is declined from the Equinoctiall towards either of the Tropicks, by which the increase and decrease of the dayes and nights are known.

Eightly, Between the Equinoctial ÆG, and the Tropicks S B, are drawn divers other crooked lines, of which, those 4 lines which are pricked in this manner ..... and bend towards the left hand, the first being numbered with 7 at one end, and 5 at the other, representeth the houre of 7 of the clock in the forenoon, or of 5 a clock in the afternoon: the second is figured with 8 and 4: the third with

9 and

9 and 3 : the fourth with 10 and 2 : the fifth with 11 and 1 : theſixth with 12 : and theſe lines repreſent thoſe hours of the day, as the figures ſet to them do declare. Thoſe nine other lines which are drawn with a full line thus ———— , and bend towards the right hand, of which, the firſt of them towards the right hand is marked with 12, repreſenteth 12 of the clock at noon, the ſecond is noted with 1 at one end and 11 at the other, the third with 10 and 2, the fourth with 9 and 3, the fifth with 8 and 4, the ſixth with 7 and 5, the ſeventh with 6 and 6, the eighth with 5 and 7, and the ninth with 4 and 8, repreſenting thoſe hours of the day either before or afternoon.

Note, that the ſix forementioned houre-lines which are pricked in this manner . . . . . are called the

the *Winter-houre-lines*, and are in use only for the Winter season, as from the 12 of *September* til the 10 of *March*; And the other nine lines drawn thus ———, are called the *Somer-houre-lines*, and are in use from the 10 of *March* to the 12 of *September*.

Note also, That if the Quadrant be made large enough, each hour may be divided into halves and quarters, or into smaller parts, and (as Mr. *Gunter* (the contriver of this Quadrant) rightly saith) If it be made of a Foot semidiameter, it will shew the *Azimuth* unto a Degree, and the time of the Day unto a Minute.

Ninthly, Between the Equinoctial Æ G, and the Tropicks S B, are drawn (towards the other side of the Qua-

Quadrant A M, divers other crooked lines, called *Azimuths*, in the same order and form that the Houre-lines are drawn: of which lines, those that bend from the left hand towards the right, and pricked thus . . . . . are the Azimuths in use for the Winter Season, *viz.* from the 12 of *September* to the 10 of *March*: and those that bend from the left hand towards the right, and drawn with a full line thus ———— , are the Somer Azimuths, and are in use from the 10 of *March* til the 12 of *September*. These Azimuth lines shew at all times of the day, and any time of the year, how far the Sun is distant from the Meridian, which is of excellent use, not only in Navigation, but in Dialling also, and many other good purposes: These *Azimuths* are numbred by 10, 20, 30, 40, &c. to 120. degrees,

Tenthly, Amongst these Houre

and

aud Azimuth lines, may be inſerted any fixed Stars that lie between the Equinoctial and the Tropicks, but becauſe the Quadrant ſhould not be over much cumbered, Mr. *Gunter* hath made choice only of 5 ſelect Stars, lying very convenient for obſervation at all times of the year, and thoſe are theſe: *Pegaſus Wing*, *Arcturus*, *Lyons heart*, *Buls Eye*, *Vultures heart*.

Eleventhly, To this Quadrant (as to others) there belongeth two Sights of Braſſe, as alſo a Thrid and Plummet, with a ſmall bead or Pins head, to ſlip up and doun upon the ſtring at pleaſure. Thus is the *Quadrant* fitted to performe the uſes following.

The

# THE *Uses of the several lines that are described on the* QUADRANT.

HAving thus given you a true and perfect description of the severall Lines that are upon the *Quadrant*, it will be necessary now to shew you the uses of them severally, which I shall briefely and plainly do in the following *Propositions*. And,

## I. Of the Quadrants Limb.

PROP. I. *How to take the Altitude of the* Sun, Moon *or* Stars.

BEcause many of the *Propositions* following require the Suns Altitude

to

to be given, it will be neceſſary to ſhew you how to take it by the *Quadrant* at any time, the Sun ſhining.

Upon the edge of your Quadrant are two ſights for this purpoſe. Take the Quadrant in both your hands, laying your right hand ſomewhat neer that ſide that hath the Sights, and your left hand towards the other ſide, by which means you may let it ſlip lower, or raiſe it higher, as occaſion requires. Then turning the left ſide of your Body to the Sun, hold the Quadrant in both your hands, as is before directed, and move it up or down in your hand, till the Sun ſhining through that ſight which is next the Centre of the Quadrant, do caſt his Ray or Beam of light upon the hole of the other Sight, at which inſtant, look in the Limb of the Quadrant what degrees and part of a degree the thrid reſteth upon, for thoſe degrees are the degrees

of

of the Suns Altitude. Thus for taking the Suns Altitude, but for the Moon and Stars you must do otherwise, namely thus: Hold the Quadrant in both your hands, as before, and looke through both the Sights till you espie the *Moon* or *Star* whose Altitude you require, which when you have found, look what degrees the thrid cut in the Limb of the Quadrant, for those degrees are the Altitude of the *Moon* or *Star* you look at.

Likewise in the taking of Altitudes of Buildings, &c. you must looke through the Sights, till you see (through them) the top of the Object, whose height you would know.

## II. Of the *Circle of Moneths.*

BEfore we come to shew the use of these Circles, it is requisite to shew you to what use the *Bead* that is upon

upon the ſtring ſerveth, and how to *Rectifie* or ſet it for any day of the year, which is as followeth.

## *How to Rectifie the Bead.*

The thrid being fixed in the centren of the Quadrant, and the Bead upon it, lay the thrid upon any day of any Moneth, and there with the Thumb of your left hand hold it faſt, and with the Naile of the finger or thumb of your right hand, ſlip the Bead upon the thrid (either upwards or downwards) till the Bead lies juſt upon the Houre-line of 12, and there let the Bead reſt, for then it is rectified or ſet for that day of the year upon which the thrid lyeth. This we ſhall hereafter call *The Rectifying of the Bead.*

PROP. 2. *Any day of the year being given, to finde what other day of the year is of the same length therewith.*

SUppose it were required to finde what day of the yeare is of equall length with the 18 day of *October*. Lay the thrid to the 18 day of *October* in the lower Circle of Moneths, then will the thrid lie upon the 2 day of *February* in the upper circle of Moneths, which day is of equall length with the 18 of *October*. In this kind you may find, the

| | | |
|---|---|---|
| *March* 1 | | *September* 21 |
| *August* 12 | equall to | *Aprill* 11 |
| *May* 1 | | *July* 22. |

And so of any other day of the year.

PROP. 3. *The day of the moneth given, to finde the Suns place in the Ecliptick.*

LEt the day given be the 16 of *Aprill*, Lay the thrid to the 16 of *Aprill*, and

and rectifie the Bead to 12, as hath been already taught, then move the thrid upon the Quadrant til the Bead lyeth upon the Ecliptick line, ſo ſhall the Bead cut the Ecliptick line in 6 deg. 43 min. of *Taurus*, in which ſigne and degree the Sun is upon the 16 of *April*.

Note, That from the 10 of *March* to the 12 of *September* the Sun is in thoſe ſignes that are charactered on the upper part of the Ecliptick line: [and hath North Declination:] But from the 12 of *September* to the 10 of *March*, he is in thoſe Signes that are charactered below the Ecliptick line, [and hath South Declination.]

So ſhall you finde that on

| | | | *deg.* | *min.* | |
|---|---|---|---|---|---|
| *January* 12 | the Sun | | 3 | 12 | *Aquarius* |
| *April* 26 | will be | | 16 | 23 | *Taurus* |
| *September* 1 | in | | 19 | 1 | *Virgo* |

PROP. 4. *The day of the Moneth being given, to finde the Declination.*

UPon the 9 of *Aprill*, let it be required to find the Declination. Lay the thrid to the Day given, and rectifie the Bead as before, then bring the Bead to the line of Declination, and it will fall upon 11 deg. 30 min. and such is the Declination for that day, Northward.

PROP. 5. *The day of the moneth being given, to finde the Meridian altitude.*

THe Day given is the 9 of *Aprill*, Lay the thrid thereto, and in the limb of the Quadrant it will cut 50 deg. which is the Meridian altitude.

PROP. 6. *The day of the moneth being given, to finde the Amplitude.*

LEt it be required to finde the Amplitude upon the 15 of *May*, Lay the

the thrid to the day of the moneth, & rectifie the Bead, then bring the Bead to the Horizon, and it will fall in 35 deg. 8 min. which is the Amplitude for that day: For then doth the Sun riſe 35 deg. 8 min. from the Eaſt towards the North; and ſets 35 deg. 8 min. from the Weſt towards the North.

Note, When the Sun hath South Declination, the Amplitude of his riſing and ſetting is from the Eaſt or Weſt towards the South.

PROP. 7. *The day of the moneth being given, to finde the Aſcenſional difference: and thereby the time of the Suns Riſing or Setting, with the length of the Day and Night.*

LEt the day given be the 15 of *May*, Rectifie the Bead for that time, and bring it til it touch the Horizon, then will the thrid cut the limb of the

Quadrant in 28 deg. 50 min. which is the Aſcenſionall difference.

From the Aſcenſionall difference thus found may the time of the Suns riſing and ſetting be computed, and thereby the length of the day and night, in this manner.

Convert the aſcenſional difference into time, by allowing 15 deg. to an houre, and a degree to 4 minutes of time. Thus, on the 15 of *May*, the aſcenſional difference being found as before, to be 28 deg. 50 min. which converted into time maketh 1 houre, and 55 minutes of an houre; wherefore that day [it being in Somer] the Sun did riſe 1 houre and 55 minutes before 6 of the clock, and did ſet as much after 6 at night: that is it did riſe 5 minutes after 4 in the morning, and did ſet 5 min. before 8 at night.

Now

Now if you double the time of the Sun riſing you have the length of the night: and the time of the Sun ſetting doubled gives the length of the day. Thus on the 15 of *May* the night will be found to be 8 hours 10 min. long, and the day 15 hours and 50 min. long.

PROP. 8. *The day of the moneth being given, to finde the altitude of the Sun at all the hours of the day.*

HAving rectified the Bead for the day given, move it from houre to houre, and what degrees in the limb are cut by the thrid, are the degrees of altitude at thoſe hours.

Thus if the day given were the 8 of *February*, the bead rectified and carryed along from houre to houre, the thrid would cut the limb at every hour in ſuch degrees and minutes as are expreſſed in this Table following.

| Hours | | Deg. | min. | |
|---|---|---|---|---|
| XII | | 27 | 1 | |
| I | XI | 25 | 40 | |
| II | X | 21 | 51 | Altitudes at |
| III | *or* IX | 15 | 58 | these hours. |
| IV | VIII | 8 | 33 | |
| V | VII | 0 | 6 | |

## III. Of the *Ecliptick* line.

PROP. 9, *The place of the Sun in the* Ecliptick *being given, to finde the day of the moneth.*

LEt the place of the Sun given be in 27 deg. of *Aries*. Lay the thrid upon 27 degrees of *Aries*, and bring the Bead thereto, then move the thrid along till the bead lies upon the houre line of 12, then will the thrid cut upon the 6 of *Aprill*, which is the day of the moneth required.

PROP.

PROP. 10. *The place of the Sun in the* Ecliptick *being given, to finde his Declination.*

THe Sun being in 27 deg. of *Aries*, I let the Bead be rectified thereto, as in the laſt Propoſition, then bring the Bead to the line of Declination, and it will fall upon 10 deg. 27 min. which is the Declination for that day Northward, becauſe it is in Somer.

PROP. 11. *The place of the Sun being given, to finde his Right Aſcenſion.*

IN this Propoſition there is no need of the Bead, for the thrid being laid upon the Suns place in the Ecliptick, it will cut the limb of the Quadrant in the Right aſcenſion.

Let the Suns place given be in the fourth deg. of *Gemini*, the thrid laid thereto will cut the limb in 62 degrees

and

and that is the Suns right aſcenſion when he is in 4 degrees of *Gemini*.

¶ Note, that the Right aſcenſion is numbered from one deg. to 360 degrees, and is to be accounted according to the Suns diſtance from the firſt degree of *Aries*, for if the Sun be more then 90 deg. from the beginning of *Aries*, there muſt be more then 90 deg. allowed for the Right aſcenſion.

So if the Sun be in 26 deg. of *Cancer*, the thrid being laid thereto will fall alſo upon 62 deg. and yet the right aſcenſion muſt be counted 118 deg, Likewiſe, if the Sun were in 4 deg. of *Sagitarius*, the thrid will fall in the ſame place, but the right aſcenſion muſt then be accounted 242. and if the Sun be in 26 deg of *Capricorn*, the right aſcenſion muſt be accounted 298 deg. the like for any other.

PROP, 12. *The Suns place in the Ecliptick being given, to find the Amplitude.*

THe thrid laid to the Suns place in the Ecliptick, bring the Beade thereto, then move the ſtring till the Bead touch the Horizon, and it will there ſhew you the Amplitude.

Thus, the Sun being in 4 deg. 37 min of *Gemini*, the Bead rectified thereto, being brought to the Horizon, wil cut it in 35 deg. 8 min. which is the Amplitude at that time.

## IV. Of the *Horizon.*

PROP. 13. *The Suns Amplitude being given, to finde the Declination.*

PLace the Bead upon the degree of Amplitude given in the Horizon, then bring it to the line of Declination and it will there fall upon the degree of the Suns Declination.

So

So the given Amplitude being 35 deg. 8 min. the Bead laid thereto in the Horizon, and carryed to the line of Declination will fall upon 21 deg. 9 min. the Declination.

PROP. 14. *The Amplitude being given, to finde the day of the Moneth.*

THe Bead being laid to the degree of Amplitude in the Horizon, & carryed from thence to the Houre-line of 12, either in Winter or Somer, the thrid will fall upon the day of the Moneth.

So the Amplitude being 35 deg 8 min. the Bead laid thereto, bring it to the Houre-line of 12 in Somer, and the thrid will cut upon the 15 of *May*, and the 7 of *July*, on both which days the Sun hath 35 deg. 8 min. of Amplitude.

But if it be in Winter, carry the Bead to the Winter Houre-line of 12, and

and the thrid will fall upon the 4 of *January*, or the 16 of *November*, upon either of which dayes the Sun hath like Amplitude, Southward as it had in Somer Northward.

## V. Of the *Houre-lines*.

PROP. 15. *The Altitude of the Sun, and Day of the Moneth being given, to finde the Houre of the Day.*

HAving obſerved the Suns Altitude, as is taught in the Firſt PROP. let the Bead be rectified to the Day of the Moneth, and bring the thrid to the Suns Altitude, then ſhall the Bead fall upon the Houre of the Day.

Let the time given be the 10 of *April*, Having rectified the Bead for the day, and found the Suns Altitude to be 36 deg. the Bead at that time will fall upon the Houre-line of 9 and 3, which ſhew-

ſheweth that it is either 9 of the clock in the forenoon, or 3 in the afternoon.

But if on the ſame day you obſerve the Altitude to be about 40 deg. you ſhall finde the Bead then to fall about halfe way between the houre-lines of 9 & 3, and of 10 & 2, wherefore the Houre muſt be either halfe an houre paſt 9 in the morning, or halfe an hour paſt 2 in the afternoon, and which of theſe is the true houre is eaſie to determine. But if it be neer noon, as between 11 and 1 of the clock, then the ſureſt way to finde the true Houre is by a ſecond Obſervation of the Altitude; for, if the altitude increaſe it is the forenoon-hour, but if the altitude decreaſe, it is the afternoon-houre.

PROP. 16. *The Houre of the Day being given, to finde the Altitude of the Sun.*

RECtifie the Bead to the time given and bring it to the Houre given, then

then will the thrid ſhew upon the Quadrants Limb the degrees of the Suns altitude at that houre.

So if the Day given were the 9 of *Aprill*, and the altitude of the Sun at 8 in the morning or 4 in the afternoon were required. The bead being rectified to the 9 of *Aprill* and brought to the houre-line of 8 & 4, the thrid wil cut the Quadrants limb in 27 deg. 31 min. and ſuch altitude will the Sun have at 8 or 4 of the clock upon the 9 day of *April*.

PROP. 17, *The Houre of the Night being given, to finde how much the Sun is below the Horizon.*

OBſerve this generall Rule, The Sun is alwayes ſo much below the horizon at any hour of the night, as his oppoſite point is above at the like houre of the day, So that if the Queſtion be in Somer, you muſt uſe the

the Winter-houre-lines, and in Winter the Somer-hour-lines.

Let it be required to finde how much the Sun is below the Horizon, upon the 10 of *April* at 4 of the clock in the Morning. Set the Bead to his place according to the time in the Somer hours, then bring the Bead to 4 of the clock in the Winter-hours, ſo ſhall you find the thrid to fall upon 8 deg. and an halfe, and ſo much is the Sun below the Horizon at that time.

PROP. 18 *To finde the time of Day break, and end of Twy-light.*

DAy is ſaid to begin to breake when the Sun is 18 deg below the horizon in the Eaſt: and Twy-light is ſaid to end when the Sun is 18 deg. below the horizon in the Weſt. Therefore rectifie the bead for the given time, and lay the thrid upon 18 deg. in the Quadrants limb, the bead among

among the contarry hour-lines ſhall ſhew the time of Twy-light.

So the time given being the 10 of *Aprill*, ſet the bead to the time in the Somer-hours, then bring the bead to 18 deg. in the Quadrants limb, ſo ſhall the bead among the Winter houre-lines, fall ſomewhat more then a quarter before 3 in the morning: at which time the day begins to break.

## VI. Of the *Azimuth-lines*.

PROP, 19. *Having the time of the Yeare and the Altitude of the Sun given, to finde the Azimuth.*

YOur bead being rectified for the time given, make obſervation of the Suns altitude, which done, bring the thrid to the complement of that altitude, that is, [Count the degrees of the Suns altitude (not as they are figured upon the Quadrant, but) from

the right hand towards the left, that is, call 80 deg. 10 deg. 70 deg. call 20 deg. &c.] then will the Bead among the Azimuth lines shew the Azimuth from the South, according as they are numbered.

*Example*, Upon the second of *August* in the forenoon (having rectified the Bead for that day) I observed the Suns altitude to be 47 deg. 48 min. I lay the thrid upon 47 deg. 48 min. counted from the right hand towards the left, and the bead among the Azimuth lines will fall upon that line that is figured with 40, which shews that the Sun is 40 deg. distant from the South towards the East, because the altitude was taken in the forenoon; whereas, if the same day the like altitude had been taken in the afternoon, the Azimuth would have been 40 deg. from the South towards the West.

PRG P. 20. *The Suns* Azimuth *and day of the moneth given, to finde the Suns* Altitude.

REctifie the Bead for the day given, and bring it to lie upon the Azimuth given, then will the thrid lie upon the complement of the Suns Altitude.

Thus; Upon the second of *August* the Suns Azimuth was observed to be 40 degrees from the South towards the West, the bead being rectified and laid upon the 40th Azimuth, the thrid at the same time will lie upon 42 deg. 12 min. the complement of the Suns Altitude.

¶ Note, The complement of the Suns altitude is so much as the altitude wants of 90 degrees: So if the complement of the altitude be 50 deg. the true al-

titude is 40 deg. if 60, then 30, &c.

## VII. Of the *Stars* upon the Quadrant.

PROP. 21. *Having the altitude of any of the Stars given, to finde thereby the Houre of the Night,*

THe five Stars that are upon the Quadrant are these, and their Right Ascensions in Hours and Minutes are as in this Table.

| ✶ *Names* | ✶ *Right Ascension.* H | M |
|---|---|---|
| *Pegasus Wing* | 23 | 45 |
| *Arcturus* | 14 | 01 |
| *Lyons Heart* | 9 | 51 |
| *Buls eye* | 4 | 17 |
| *Vultures Heart,* | 19 | 34 |

Upon the 15 of *May* I see *Arcturus,*

I ſet the Bead to it in the Quadrant, and obſerve his altitude, and finde the altitude to be 52 deg. high, at which time the bead falls upon the Houre-line of 2 afternoon, this number note. Then (by the 11 PROP.) I finde the Right Aſcenſion of the Sun to be 62 deg. which turned into time (by allowing 15 deg. for an hour, and 1 deg. for 4 min.) makes 4 hours 8 min. then the Right Aſcenſion of *Arcturus* is 14 hours 1 min. the leſſer of theſe Right Aſcenſions taken from the greater, leaveth 9 hours 53 minutes, to which adde the former 2 hours, and it maketh 11 hours 53 min. which is the houre of the night.

# A Description of the QUADRAT.

BEtweene the Æquinoctiall and the centre of the *Quadrant* is a vacant place, in which is drawn a QUADRAT, noted with these Letters A O D P, two sides whereof, namely, those fartheſt from the centre, as O D and P D, are divided each into 50 equall parts, and numbered by 10, 20, &c. to 50.

Of these two sides, that which is noted with O D, is called the parts of *Right Shadow*, and the other noted with P D is called the parts of *Contrary Shadow*. Thus much for the Description of the QUADRAT, its Use followeth.

The

# The Use of the QUADRAT.

PROP. I. *How to take the Altitude or Height of any* Tower, Tree, Steeple, *or any other Object, which ſtandeth perpendicular, or upright.*

EVery Object that you look upon, is either higher or lower than your Eye, or equall with it. Now ſuppoſe you ſee a Tower, and are required to finde the height thereof, Lift up the Quadrant, holding it ſo that the thrid may eaſily play by the ſide of it, and looke through the Sights till you eſpie the top of the Tower, then go backwards or forwards till the thrid fall juſt

juſt upon 50 parts, which is at D, then if you meaſure from your place of ſtanding to the foot of the Tower, (& adde thereto the height from your eye to the ground, that diſtance ſhall be equall to the height of the Tower.

*Example* I. Thus if you doe looke through the Sights, and ſee the top of the Tower, and the thrid cut juſt upon 50 parts of the Quadrat; and the diſtance from the place of your ſtanding to the foot of the Tower be 120 foot, add thereto 5 foot for the height of your eye from the ground, and it makes 125 foot, and that is the height of the Tower.

*Example* II. But if the ground will not permit you to ſtand ſo that the thrid may fall juſt upon 50 parts, then go backwards till it fall upon 25 parts of *Right Shadow*, then will halfe the diſtance between your place of ſtanding and the foot of the Tower, (adding

ding the height of your eye thereto) be equal to the Towers height.

Thus looking through the ſights to the top of the Tower, and the thrid falling upon 25 parts of *Right Shadow*, you finde the diſtance from your foot to the Tower to be (adding 5 foot your height thereto) 232 foot, the half whereof is 116 foot for the Towers height.

*Example* III. If again the ground will not permit you to ſtand ſo that the thrid may fall upon neither of theſe places, go yet farther backwards till the thrid fall upon 12 parts and an halfe of *Right Shadow*, then will one quarter of the diſtance be equall to the height. For this *Rule* is generall:

As 50,
to the parts on which the thrid falls,
So is the diſtance,
to the height.

There-

Therefore,

*Example* IV. Taking a place at all adventure, where you may most conveniently stand to see & measure, Suppose the thrid fall upon 42 parts of *Right Shadow*, and the distance between the Tower and your standing (with your height added) to be 86 foot. Multiply 42 [the parts cut,] by 86 foot [the distance,] & it makes 3612, which divide by 50 [the whole side of the *Quadrat*] and it produceth $72\frac{12}{50}$: which is 72 foot, and almost 3 inches, for the height.

## *When the thrid falls on the parts of* Contrary Shadow.

If the thrid fall upon 25 parts, the height is double to the distance. If on 12 parts and an halfe, the height is four times the distance. But in generall, Thus,

As the parts cut by the thrid,
are to 50: So

So is the distance,
To the Height.

*Example* V. If the thrid fall on 36 parts of *Contrary shadow*, and the distance from your standing to the foot of the Tower be 23 foote: Multiply 23 [the distance,] by 50 [the side of the Quadrat,] and it maketh 1150, which divide by 36 [the parts cut of *Contrary shadow*,] the Quotient is $31\frac{34}{36}$ that is, 31 foot, 11 inches, and one third part of an inch [for the height of the Tower.]

¶ Note, That what hath hitherto been said concerning the taking of Heights, the same is to be understood of Distances also, only in the taking of Distances, *Right shadow* must be taken for *Contrary shadow*, and *Contrary* for *Right*.

PROP. 2. *How to take an Altitude at two ſtations.*

MAny times it will fall out ſo that you cannot come cloſe to the foot of the Object to meaſure, either in reſpect of water or other hinderance in ſuch caſes you muſt uſe 2 Stations.

*Example* I. Suppoſe that looking through the ſights and ſeeing the top of the Object you would meaſure, the thrid falls on 25 parts of *Right ſhadow*, at the ſecond ſtation it falls upon 20 parts: Now you muſt ſuppoſe the height of the Object to be any number of feet, as 100. then the *Proportion* is

As 25 the parts cut at the firſt ſtation,
is to 50 the Quadrats ſide,
So is 100, the ſuppoſed height,
to 200 the diſtance to the Object.

Then ſay again,

*As*

As 40, the parts cut at the ſecond ſtat.
are to 50, the Quadrats ſide,
So 100 the ſuppoſed height,
to 250 the diſtance from the ſecond
ſtation to the foot of the Object.

The difference between theſe two numbers 250 and 200, is 50, which ſhould be the diſtance between your two ſtations, but meaſuring thereof you finde it to be but 30 foot: Then

As 50. the ſuppoſed differenre,
to 30, the true difference,
So 100, the ſuppoſed height,
to 60, the true height.

The

# The Description of the NOCTURNAL.

*For the ready finding of the* Houre *of the* Nighr, *and other good purposes.*

UPon the back-side of the Quadrant may very commodiously be described a NOCTURNAL, such as Mr. *Gunter* mentions in his Booke of the SECTOR, Which Nocturnall consisteth of two parts, the one fixed, and the other moveable.

The fixed part consists of a Circle equally divided into 24 hours, and those into halves and quarters, the line fi-

figured with XII, represents 12 of the clock at night.

The other part of this Nocturnall is moveable, whose outermost Circle is divided into 12 parts, representing the 12 Moneths, each moneth having its name thereunto affixed, and numbered by 10, 20, &c. every fifth and tenth day, being distinguished from the rest by a longer line.

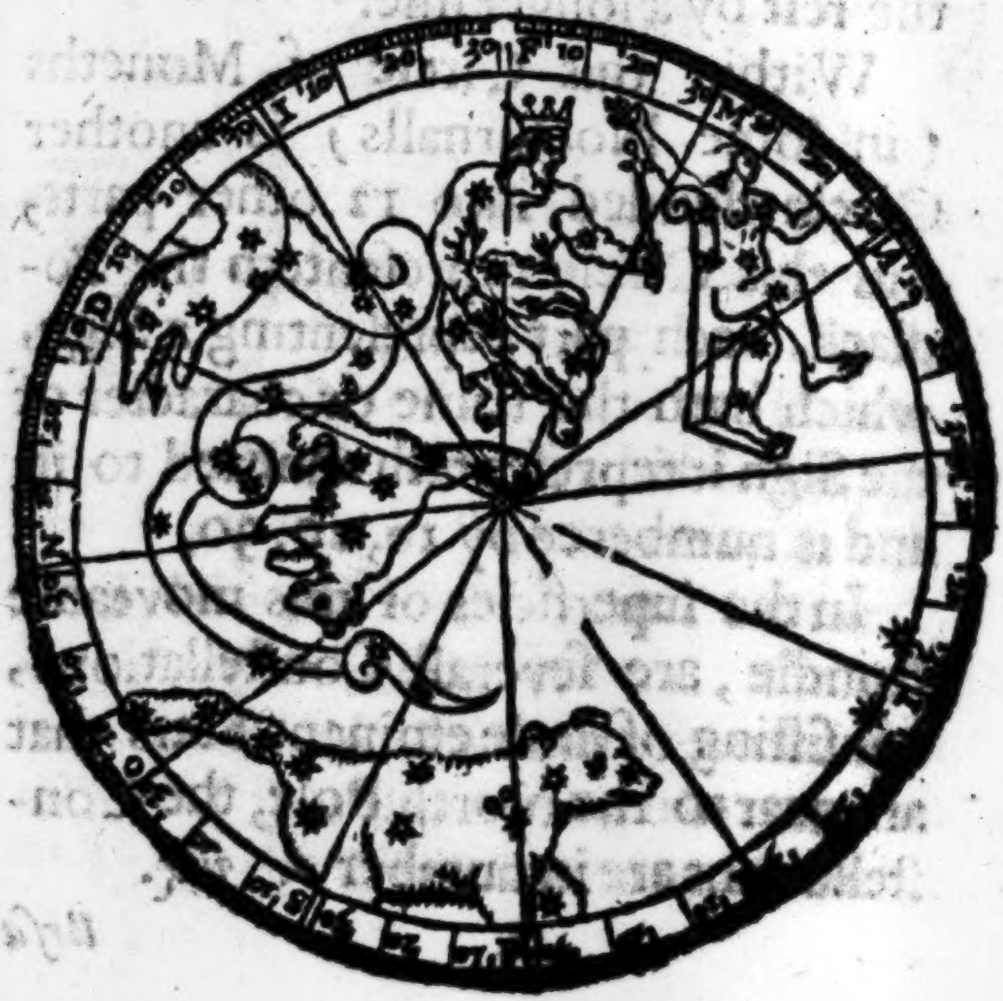
Within this Circle of Moneths (in some Nocturnalls) is another Circle divided into 12 other parts, and this Circle representeth the Zodiack, each part representing a Sign, which hath the name or character of the Sign it representeth annexed to it, and is numbered by 10, 20, 30.

In the superficies of this moveable Rundle, are severall Constellations, consisting of those eminent Stars that are near to the North Pole, the Constellations are in number 7. *viz.*

*Ursa*

*Ursa Major*, or the Great Bear, *Ursa Minor*, *Draco*, *Cepheus*, *Cassiopea*, *Auriga*, *Cygnus*. As in this Rundle.

From the centre of this Rundle to the Circumference thereof, are drawn 12 lines, representing so many Meridians, the use of them will appear hereafter, and so let thus much serve for its description.



# The Use of the NOCTURNAL.

BEfore I ſhew the uſe of the NOCTURNAL, I ſhall (for the ſatisfaction of thoſe that do not already know how to effect it) ſhew how by the North Star to finde the Meridian in the Heavens, which may be thus effected.

PROP. 1. *How to finde a Meridian line.*

THere are many wayes to effect this, but the readieſt way is by the North Star, which Star is within two degrees and an halfe of the North Pole. The North Pole lies about the mid

way between *Allioth*, or the root of the *Great Bears Tail*, and this Star: thus you may imagine a right line drawn from the North Srar to *Alioth*, and by your imagination suppose two third parts of the distance of the next Star of the Little Bears Tail from the Pole-star towards *Allioth*, for there is the very Pole point, as by this Figure it doth plainly appear.

Now then if you set up 2 poles aslope, and from the tops of them hang 2 cords with weights at the ends of them, & turn them, till you standing on the South side of them, may see them both together with the Pole point, as it were all in one right line, then doth the two Cords

Cords hang in the Meridian of the place. In this Diagram I have given you the chiefe Stars of the Great and little Bears, ſo that by them you may come to know the other Stars that are figured in your Nocturnall.

PROP. 2. *How to finde the Right Aſcenſion of any of the Stars in the Rundle.*

LAy the thrid upon that Star whoſe right Aſcenſion you would know, then count what number of degrees are contained between the thrid and the firſt degree of *Aries*, (counting them according to the courſe and order of the Signes ) as from *Aries* by *Taurus*, *Gemini*, &c. to the thrid, the whole number of thoſe degrees is the right Aſcenſion of that Star.

*Example.* Let it be required to finde the right Aſcenſion of the Star in the end of the great *Bears* tail. Lay the thrid

thrid upon this Star, and it will cut the Circle which representeth the Zodiack in about the 24 degree of *Libra*, that is 6 Signes, which is 180 deg. and 24 deg. more, which is in all 204 deg. and such is the right Ascension of the bright Star in the end of the great *Bears* tail.

PROP. 3. *To finde the Declination of any of the Stars expressed in the Nocturnall.*

FOr this purpose (in some Nocturnalls) one of the 12 lines that issue from the centre of the Nocturnall, is divided into uneqnall parts, and numbered with Arithmeticall Figures. Now to finde the Declination of any Star, set one foot of a pair of Compasses in the pole or centre of the Nocturnall, and extend the other foot to the star whose declination is required: Then bring the moveable foot of the Compasses

Compaſſes to the divided Meridian, and note upon what degree it reſteth, which number of degrees being taken from 90, leaveth the declination of the ſtar required.

Thus if you would know the declination of the forementioned ſtar, extend the Compaſſes from the Pole to the ſtar, this diſtance applyed to the divided Meridian, will reach from the Pole to 38 deg. 45 min. which being taken from 90 deg. leaveth 51 deg. 15 min. for the declination of the ſtar.

PROP. 4. *Any of the Stars in the Nocturnall, being upon the Meridian any day of the Year, to finde thereby the Houre of the Night.*

FInde that ſtar upon the Nocturnall, which you ſee upon the Meridian in the Heavens, and turn the Rundle about till the ſtar lies juſt upon the Meridian line of 12 in the under Circle

Circle of hours, then against the day of the moneth in the Rundle, you have the hour of the Night in the Circle of hours.

*Example.* Upon the first day of *April* I see the ſtar which is in the Rump of the great *Beare* tail upon the Meridian in the Heavens, I finde this ſtar in the Rundle, and turn the Rundle about till this ſtar lies juſt over the line of 12 in the hour Circle, then in the Rundle finde the firſt of *April*, againſt the which you ſhall finde in the houre Circle 11 of the Clock, and one quarter paſt, which is the hour of the night.

FINIS.